Citation:

Hollis JH, Mattes RD. Effect of increased dairy consumption on appetitive ratings and food intake. *Obesity (Silver Spring)*. 2007 Jun;15(6):1520-6. Erratum in: *Obesity (Silver Spring)*. 2007 Oct;15(10):2520.

PubMed ID: 17557989

Study Design:

Nonrandomized Crossover Trial

Class:

C - Click here for explanation of classification scheme.

Research Design and Implementation Rating:

NEUTRAL: See Research Design and Implementation Criteria Checklist below.

Research Purpose:

The purpose was to assess the effect of daily intake of one or three portions of dairy foods on energy intake and appetite.

Inclusion Criteria:

- Subjects who were in good general health
- 18 to 50 years of age
- BMI between 25 and 32 kg/m2
- Not lactose intolerant
- Willing to consume the test foods
- Regular low dairy intake (200 mg/day of calcium from dairy products) or high dairy intake (600 mg/day from dairy products). A food frequency questionnaire designed to assess dairy intake was used to classify dairy consumption.

Exclusion Criteria:

Not described but assumed to be subjects who did not meet inclusion criteria.

Description of Study Protocol:

Recruitment

- Individuals with regular low or high dairy intake
- A screening questionnaire was used to obtain demographics, health status, and usual dairy intake.

Design: Nonrandomized crossover trial

Blinding used - When participants were in the laboratory for food measurements, they completed meaningless tasks and measurements that hid the true purpose of the study.

Intervention

- Subjects were assigned to one of two treatment groups and switched to the other treatment after the wash-out period: low dairy intake with one portion of dairy and high dairy intake with three portions of dairy.
- Subjects had to consume the entire dairy portion.
- In the low-dairy phase, subjects could choose white or chocolate milk, yogurt or hard cheese. High-dairy intake required subjects to have one milk serving, one yogurt serving, and one hard cheese serving. The flavor or type of dairy product consumed was up to the subject. Subjects were not advised how to include dairy items but were required to have 4 hours between dairy foods.
- On each day of both treatment phases, subjects were required to go to the laboratory.

Statistical Analysis

- SPSS software was used for statistical analyses.
- Data is mean ± standard deviation. Mixed-model ANOVA was used to assess differences between groups, with gender and usual dairy intake as between-subject factors and dairy condition as within-subject factor.
- Statistical significance was $p < 0.05$ (two-tailed).

Data Collection Summary:

Timing of Measurements

- Subjects had 7 days in the first treatment period of low or high dairy intake, 7 days in a wash-out period, and then 7 days of the other treatment option.

Dependent Variables

- Appetite: hand-held devices were used to record appetite with date and time stamps. Standard questions related to hunger or satiety level, thoughts related to food, and desire to eat at that moment.
- Daily energy expenditure was tracked with an accelerometer attached at the subject's waistband. A daily activity log was also used to confirm the results on the accelerometer. An estimate of basal metabolic rate was obtained from these methods with the addition of the energy cost of the activity using each subject's body weight.

Independent Variables -

- Low dairy intake and high dairy intake
- Food intake was assessed using Nutrition Data System multipass software.

Control Variables

- Habitual dairy intake

Description of Actual Data Sample:

Initial N: 60 (30 males, 30 females)

Attrition (final N): 58 (28 males, 30 females)

Age: 18 to 50 years old

Ethnicity: Not described

Other relevant demographics

Anthropometrics: BMI between 25 and 32 kg/m^2

Location: Department of Foods and Nutrition, Purdue University, West Lafayette, Indiana

Summary of Results:

Key Findings

- Overall energy intake increased by 209 kilocalories/day in the high-dairy treatment period [$F(1,52) = 28.088$, $p < 0.05$].

- No significant differences noted in hunger, satiety, desire to eat or thoughts of food in any treatment groups.
- Habitual dairy use did not influence either the appetitive or dietary findings.

Other Findings

Participant Characteristics

- No significant differences were noted among the 4 groups in terms of age or BMI.
- Female subjects weighed less than the males.
- No within-sex differences were found.

Food, Energy, and Macronutrients

- Treatment-by-sex was statistically significant in that high-dairy intake resulted in greater energy intake in males than in females [$F(1,52) = 4.100$, $p < 0.05$].
- No significant results were found between treatment and usual dairy consumption.
- Male subjects with usual high dairy intake (Group 1) reduced calories from other sources by 31%.
- Male subjects with usual low dairy intake (Group 2) did not compensate for extra calories from the extra dairy products. In fact, calorie intake actually increased by 12% more than would be estimated by adding two more dairy items to the daily diet.
- Females with usual high dairy intake (Group 3) reduced calorie intake from other foods by 72%.
- Females with usual low dairy intake (Group 4) reduced calorie intake by 50% of the dairy items.
- High dairy intake resulted in mean carbohydrate intake increase from 285 ± 87 to 310 ± 87 grams [$F(1,52) = 14.065$, $p < 0.05$]. Significant treatment-by-usual dairy intake found that the increased carbohydrate intake resulted from higher carbohydrate intake among low dairy consumers [$F(1,52) = 13.675$, $p < 0.05$].
- No significance noted in treatment-by-sex.
- Protein intake increased from 79 ± 25 to 95 ± 32 grams during the high-dairy phase [$F(1,52) = 54.711$, $p < 0.05$]. No significance was noted between sexes or low and high usual dairy intake.
- Fat intake increased during the high-dairy phase from 74 ± 25 to 79 ± 32 grams [$F(1,52) = 4.030$, $p < 0.05$]. Significant treatment-by-sex was noted in males [$F(1,52) = 4.655$, $p < 0.05$].

Energy Expenditure

- Daily energy expenditure was significantly greater than total calorie intake. This finding may indicate underreporting of dietary intake.

Author Conclusion:

In conclusion, increasing dairy consumption from one to three portions each day led to increased energy intake. These data raise questions regarding the satiating efficiency of dairy products and likelihood they will elicit precise dietary compensation. Whether increased energy intake from dairy is offset by metabolic changes induced by components in these products needs further study because recommendations to increase dairy consumption to promote bone health may pose a challenge for energy balance.

Reviewer Comments:

Test periods only lasted 7 days each. The authors question the accuracy of the energy-related results due to limitations with measures of energy expenditure.

Research Design and Implementation Criteria Checklist: Primary Research

Relevance Questions

1.	Would implementing the studied intervention or procedure (if found successful) result in improved outcomes for the patients/clients/population group? (Not Applicable for some epidemiological studies)	Yes
2.	Did the authors study an outcome (dependent variable) or topic that the patients/clients/population group would care about?	Yes
3.	Is the focus of the intervention or procedure (independent variable) or topic of study a common issue of concern to nutrition or dietetics practice?	Yes
4.	Is the intervention or procedure feasible? (NA for some epidemiological studies)	Yes

Validity Questions

1.	**Was the research question clearly stated?**	Yes
1.1.	Was (were) the specific intervention(s) or procedure(s) [independent variable(s)] identified?	Yes
1.2.	Was (were) the outcome(s) [dependent variable(s)] clearly indicated?	Yes
1.3.	Were the target population and setting specified?	Yes
2.	**Was the selection of study subjects/patients free from bias?**	Yes
2.1.	Were inclusion/exclusion criteria specified (e.g., risk, point in disease progression, diagnostic or prognosis criteria), and with sufficient detail and without omitting criteria critical to the study?	Yes
2.2.	Were criteria applied equally to all study groups?	Yes
2.3.	Were health, demographics, and other characteristics of subjects described?	Yes
2.4.	Were the subjects/patients a representative sample of the relevant population?	Yes
3.	**Were study groups comparable?**	Yes
3.1.	Was the method of assigning subjects/patients to groups described and unbiased? (Method of randomization identified if RCT)	Yes
3.2.	Were distribution of disease status, prognostic factors, and other factors (e.g., demographics) similar across study groups at baseline?	Yes
3.3.	Were concurrent controls used? (Concurrent preferred over historical controls.)	Yes
3.4.	If cohort study or cross-sectional study, were groups comparable on important confounding factors and/or were preexisting differences accounted for by using appropriate adjustments in statistical analysis?	N/A

3.5.	If case control or cross-sectional study, were potential confounding factors comparable for cases and controls? (If case series or trial with subjects serving as own control, this criterion is not applicable. Criterion may not be applicable in some cross-sectional studies.)	N/A
3.6.	If diagnostic test, was there an independent blind comparison with an appropriate reference standard (e.g., "gold standard")?	N/A
4.	**Was method of handling withdrawals described?**	Yes
4.1.	Were follow-up methods described and the same for all groups?	Yes
4.2.	Was the number, characteristics of withdrawals (i.e., dropouts, lost to follow up, attrition rate) and/or response rate (cross-sectional studies) described for each group? (Follow up goal for a strong study is 80%.)	Yes
4.3.	Were all enrolled subjects/patients (in the original sample) accounted for?	Yes
4.4.	Were reasons for withdrawals similar across groups?	???
4.5.	If diagnostic test, was decision to perform reference test not dependent on results of test under study?	N/A
5.	**Was blinding used to prevent introduction of bias?**	Yes
5.1.	In intervention study, were subjects, clinicians/practitioners, and investigators blinded to treatment group, as appropriate?	Yes
5.2.	Were data collectors blinded for outcomes assessment? (If outcome is measured using an objective test, such as a lab value, this criterion is assumed to be met.)	Yes
5.3.	In cohort study or cross-sectional study, were measurements of outcomes and risk factors blinded?	N/A
5.4.	In case control study, was case definition explicit and case ascertainment not influenced by exposure status?	N/A
5.5.	In diagnostic study, were test results blinded to patient history and other test results?	N/A
6.	**Were intervention/therapeutic regimens/exposure factor or procedure and any comparison(s) described in detail? Were interveningfactors described?**	???
6.1.	In RCT or other intervention trial, were protocols described for all regimens studied?	Yes
6.2.	In observational study, were interventions, study settings, and clinicians/provider described?	N/A
6.3.	Was the intensity and duration of the intervention or exposure factor sufficient to produce a meaningful effect?	???
6.4.	Was the amount of exposure and, if relevant, subject/patient compliance measured?	Yes

6.5.	Were co-interventions (e.g., ancillary treatments, other therapies) described?	N/A
6.6.	Were extra or unplanned treatments described?	No
6.7.	Was the information for 6.4, 6.5, and 6.6 assessed the same way for all groups?	Yes
6.8.	In diagnostic study, were details of test administration and replication sufficient?	N/A
7.	**Were outcomes clearly defined and the measurements valid and reliable?**	Yes
7.1.	Were primary and secondary endpoints described and relevant to the question?	Yes
7.2.	Were nutrition measures appropriate to question and outcomes of concern?	Yes
7.3.	Was the period of follow-up long enough for important outcome(s) to occur?	???
7.4.	Were the observations and measurements based on standard, valid, and reliable data collection instruments/tests/procedures?	Yes
7.5.	Was the measurement of effect at an appropriate level of precision?	Yes
7.6.	Were other factors accounted for (measured) that could affect outcomes?	Yes
7.7.	Were the measurements conducted consistently across groups?	Yes
8.	**Was the statistical analysis appropriate for the study design and type of outcome indicators?**	Yes
8.1.	Were statistical analyses adequately described and the results reported appropriately?	Yes
8.2.	Were correct statistical tests used and assumptions of test not violated?	Yes
8.3.	Were statistics reported with levels of significance and/or confidence intervals?	Yes
8.4.	Was "intent to treat" analysis of outcomes done (and as appropriate, was there an analysis of outcomes for those maximally exposed or a dose-response analysis)?	N/A
8.5.	Were adequate adjustments made for effects of confounding factors that might have affected the outcomes (e.g., multivariate analyses)?	Yes
8.6.	Was clinical significance as well as statistical significance reported?	Yes
8.7.	If negative findings, was a power calculation reported to address type 2 error?	N/A
9.	**Are conclusions supported by results with biases and limitations taken into consideration?**	Yes
9.1.	Is there a discussion of findings?	Yes

	9.2.	Are biases and study limitations identified and discussed?	Yes
10.	**Is bias due to study's funding or sponsorship unlikely?**		???
	10.1.	Were sources of funding and investigators' affiliations described?	Yes
	10.2.	Was the study free from apparent conflict of interest?	???